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RESEARCH ARTICLE

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Media framing of spiders may exacerbate arachnophobic sentiments

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Abstract

1. Spiders are able to arouse strong emotional reactions in humans. While spider bites are statistically rare events, our perception is skewed towards the potential harm spiders can cause to humans. Nevertheless, there is still limited understanding of the role of the media in spreading (mis)information about them thereby promoting this distorted perception of risk.
2. We examined the human dimension of spiders through the lens of traditional media, by analysing spider-related news published online in Italian newspapers between 2010 and 2020 (n = 314). We assessed the accuracy, circulation and sensationalistic content of each article, and assessed how each of these features drove news' share on social media.
3. We observed a recent, exponential increase in the frequency of the news, particularly those focused on medically important spiders—the Mediterranean black widow *Latrodectus tredecimguttatus* and the Mediterranean recluse *Loxosceles rufescens*. The news quality was generally poor: 70% contained different types of error, 32% were sensationalistic, and in virtually none was an expert consulted.
4. The risk scenario depicted by the media reports was unnecessarily alarmist, especially with regard to *L. rufescens*. A conservative estimate would suggest that less than 10% of the bites reported in the media reports analysed here were delivered by the species described in the report. Moreover, two out of three casualties associated with a bite of the Mediterranean recluse were fake news, while the third was unverifiable.
5. Overstated news referring to spider bites was shared significantly more on social media, thus contributing to frame a distorted perception of the risk. This is important given that these negative sentiments may ultimately lead to lowering public tolerance towards spiders and reducing conservation efforts towards them. We discuss open questions and avenues for future research concerning the media coverage of widely feared animals, that will help bridge knowledge gaps regarding the role of traditional and social media in framing our perception of the natural world.

KEYWORDS
arachnophobia, emotional contagion, envenomation, facebook, fake news, latrodectism, loxoscelism, mass media, mediterranean black widows, recluse spiders, social media, spider bite

1 | INTRODUCTION

Wildlife is an important emotional trigger in humans (Hicks & Stewart, 2018; Jacobs, 2009, 2012). Admiration and respect, surprise and excitement, but also fear and disgust are just a few examples illustrating the spectrum of emotions reported by people experiencing encounters with wildlife (Hicks & Stewart, 2018). Studies suggest that these emotional feelings toward wildlife are inborn (Davey et al., 1998; DeLoache, Pickard, & LoBue, 2010; Prokop & Tunnicliffe, 2008; Strommen, 1995), often recurring with striking similarities across diverse cultural settings (Davey et al., 1998). As a direct consequence, animal-related emotions end up playing a key role in scientific and socio-political debates around both the management and conservation of wildlife (Drijfhout, Kendal, & Green, 2020; Frank, Johansson, & Flykt, 2015; Jones, 2006; Singh, 2009; Straka, Miller, & Jacobs, 2020; Zainal Abidin & Jacobs, 2019), and in the perception of risk (Bombieri et al., 2018; Hathaway et al., 2017; Knopff, Knopff, & St. Clair, 2016; Nanni et al., 2020).

Spiders are iconic examples of animals that can bring about strong emotional reactions in humans (Hauke & Herzig, 2017; Lemelin & Yen, 2015; Mammola, Michalik, Hebets, & Isaia, 2017; Michalski & Michalski, 2010), leading to a distorted perception of risk, especially when referring to spider bites. While <0.5% of spider species are capable of causing severe envenomation in humans (Hauke & Herzig, 2017), and no proven fatality due to spider bites have occurred in the past few decades (Nentwig, Gnädinger, Fuchs, & Ceschi, 2013; Nentwig & Kuhn-Nentwig, 2013; Stuber & Nentwig, 2016), the perception of the risk associated with spider bites remains skewed towards the potential harm spiders can cause in humans (Hauke & Herzig, 2017). These feelings seemingly find their psychological roots in our ancestral fear of venomous animals (Gerdes, Uhl, & Alpers, 2009; Knight, 2008), but might also have a cultural component (Davey, 1994; Davey et al., 1998; Merckelbach, Muris, & Schouten, 1996). As Cavell (2018, p. 2) nicely put it '*… one of the most remarkable aspects of modern human-spider relations is the prevalence of arachnophobia in places with few or no highly dangerous spider species*'. Indeed, even though human–spider encounters are frequent events because spiders are omnipresent in all terrestrial ecosystems (Turnbull, 1973), including indoor environments (Bertone et al., 2016), the objective risk of being bitten by a harmful spider is minimal in most areas of the world (Diaz & Leblanc, 2007). These considerations raise the questions of why such a skewed perception of risk persists in modern societies (Lemelin & Yen, 2015).

It is known that humans have the tendency to evaluate risk through feelings and emotions rather than objectively (Slovic & Peters, 2006), often overestimating the frequency of statistically rare events. For example, many people fear flying, even though the casualties associated with civil flights are estimated to be in the order of 0.07 deaths per billion passenger miles (Savage, 2013). The same line of reasoning can be applied to people's risk judgements of low probability events related to wildlife, such as being attacked by a large carnivore (Bombieri et al., 2018) or stung or bitten by a venomous animal (Langley, 2005). Furthermore, a distorted perception of risk can be exacerbated by the way in which information is framed in the scientific literature (Bennett & Vetter, 2004; Stuber & Nentwig, 2016) or in traditional media sources (Gerber, Burton-Jeangros, & Dubied, 2011).

As far as spiders are concerned, it has been demonstrated that there is a significant overdiagnosis of spider bites and envenomation in the medical literature (Bennett & Vetter, 2004; Stuber & Nentwig, 2016; Vetter, 2004; Vetter, Hinkle, & Ames, 2009; Vetter et al., 2005; White, 2003). A recent major role in spreading falsehoods about spiders could also be associated with traditional and social media, due to their high efficiency in conveying a message more directly and reaching a wider audience (Vosoughi, Roy, & Aral, 2018). It is understood how the media plays an important role in the construction and circulation of risk images associated with animals, contributing to develop fears and ambivalence (Gerber et al., 2011). Yet, while spiders are the quintessential feared animals, there is still poor understanding of the role of the media in spreading (mis)information about them (Cushing & Markwell, 2010).

Here, we explored the human dimension of spiders in Italy through the lens of traditional and social media. We examined the media representations of human–spider encounters as published in Italian online newspapers over the past 10 years, in order to assess the accuracy, spreading and sensationalistic content of news. We tackled the following questions:

1. What is the content and quality of the information of each spider-related media report?
2. What is the temporal distribution of spider-related news?
3. Which factors determine the effective spreading of news on social media?

Our over-arching goal is to understand the potential role of online media in exacerbating arachnophobic sentiments and promoting a distorted perception of the risk associated with spider bites. This is important given that these negative sentiments may ultimately lead to lowering public tolerance towards spiders and reducing conservation efforts towards them (Knight, 2008; Simaika & Samways, 2018).

2 | METHODS

2.1 | Media report search

We adapted the methodology of Bombieri et al. (2018) for retrieving media reports on human–spider encounters published in Italian

online newspapers (Figure 1a). We carried out online searches in Italian with *Google news*, choosing multiple keyword combinations. We first searched for the Italian words for bite ('morso'), followed by spider ('ragno') and one of the years between 2010 and 2020 (e.g. 'morso ragno 2014'). We repeated the search using the word sting ('puntura') instead of bite, given that it is frequently used (incorrectly) by journalists (among others; see, e.g. Afshari, 2016). We then repeated the search, changing the noun 'ragno' (spider) to the Latin and vernacular names of spider species generally perceived as dangerous in Italy (Box 1): *Cheiracanthium punctorium* ('Ragno dal sacco giallo'), *Latrodectus tredecimguttatus* ('Argia', 'Malmignatta', 'Vedova nera'), *Loxosceles rufescens* ('Reclusa', 'Ragno eremita', 'Ragno violino') and *Zoropsis spinimana* ('Falsa licosa'). We compiled the list of species based on our experience in years of interaction with the staff of the Anti-poison Center in Milan (Centro Antiveleni) and the San Giovanni Molinette hospital in Turin, who regularly contacted us asking for expert opinions on spider identification (on average 4.6 requests/month in 2019).

This search strategy led to a total of 260 searches: 2 actions ('morso' or 'puntura') × 13 species names (the general words 'ragno', 4 Latin, and 8 vernacular species names) × 10 years (2010–2020). For each unique keyword search, we checked news up to the final available page in *Google news*, collecting all the media reports referring to one or more encounters in Italy between humans and spiders. We disregarded: (a) media reports which did not mention a specific locality for the event; (b) media reports referring to spider bite events that occurred outside Italy (e.g. a report written in Italian but focusing on a spider bite that occurred in England) and (c) media reports not specifically reporting a spider-human encounter (e.g. news discussing best practices to deal with a spider bite).

2.2 | Media report content

For each media report, we first extracted basic information: (a) title, (b) date of publication, (c) journal name, and (d) journal circulation

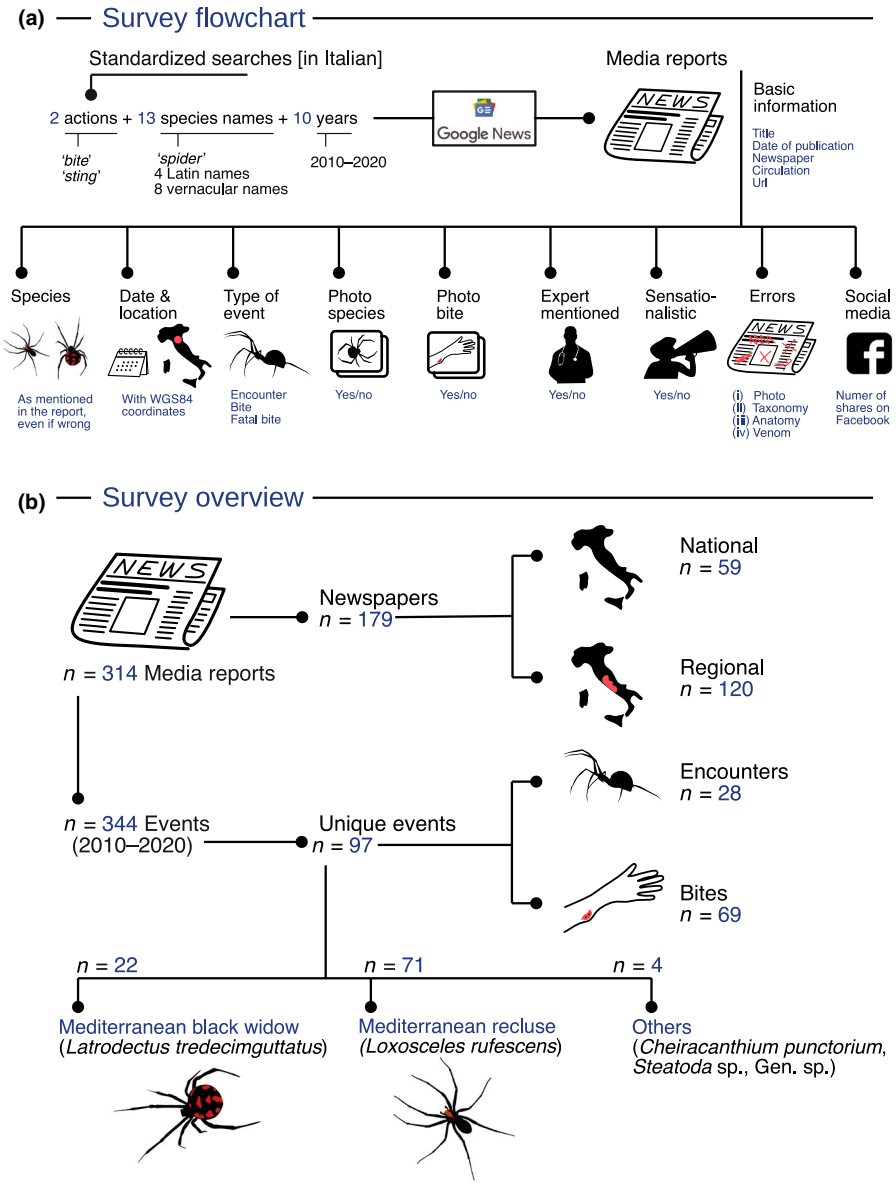


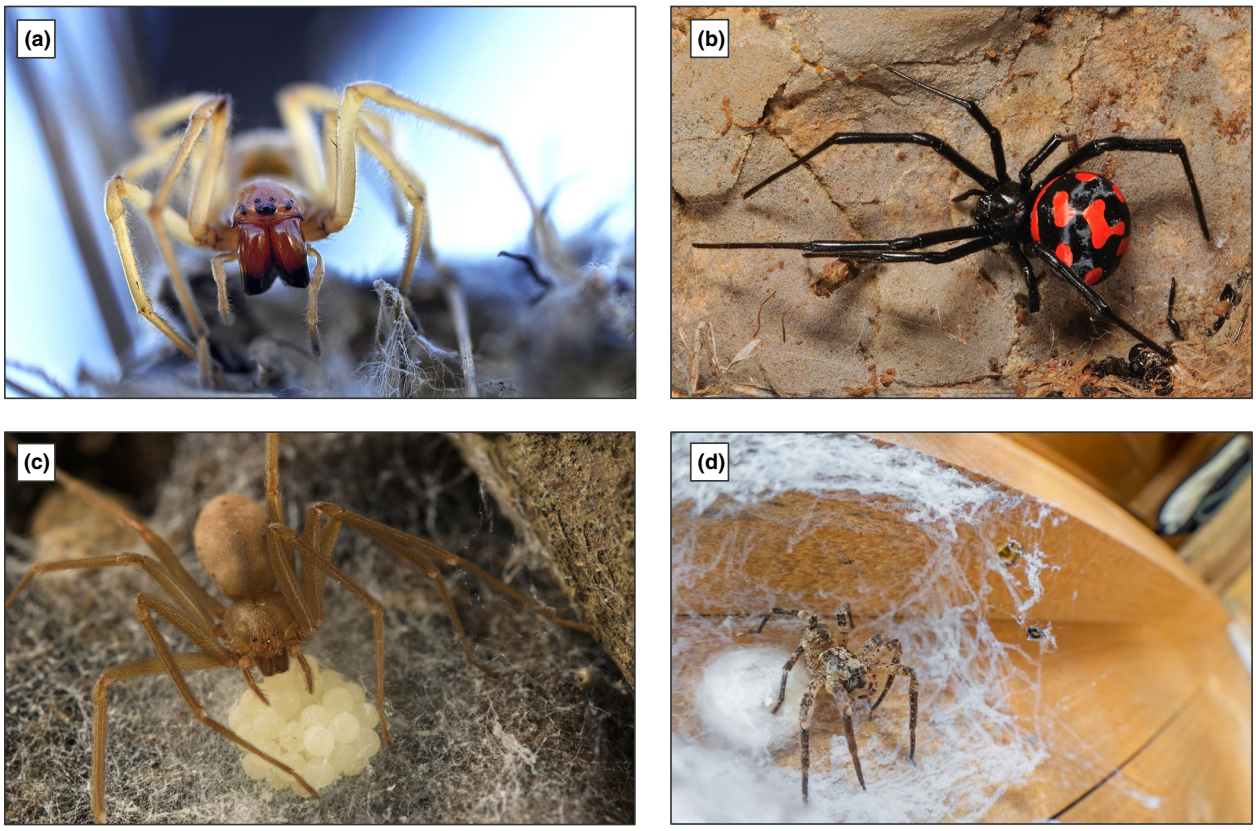
FIGURE 1 Infographic illustrating the study design and summary statistics: (a) Flowchart of the general methodology for retrieving media reports and mining relevant information. (b) Survey summary statistics

BOX 1 Spiders generally perceived as dangerous in Italy

There are only a handful of species that can potentially cause harmful bites in Italy. Based on our experience as consultants, we noticed that four species are frequently reported by people: the yellow sac spider *Cheiracanthium punctorium* (Villers, 1789; Cheiracanthiidae), the Mediterranean black widow *Latrodectus tredecimguttatus* (Theridiidae; Rossi, 1790), the Mediterranean recluse *Loxosceles rufescens* (Sicariidae; Dufour 1820) and the false wolf spider *Zoropsis spinimana* (Dufour, 1820; Zoropsidae). Among those, only *L. tredecimguttatus* and *L. rufescens* are responsible for medically important clinical syndromes, namely latrodectism and loxoscelism (see Isbister & Fan, 2011 for a description of symptoms).

Loxosceles rufescens is native to the Mediterranean basin (Planas, Saupe, Lima-Ribeiro, Peterson, & Ribera, 2014), but has been introduced to many areas of the world where it is considered an important invasive species (Nentwig, Pantini, & Vetter, 2017; Taucare-Rios, Nentwig, Bizama, & Bustamante, 2018). The Mediterranean recluse is a rather common inhabitant of natural and indoor habitats in Italy and thus, it seems likely that it has been coexisting with humans for centuries. Indeed, the species has been known in Italy since the second half of the XIX century, when the first catalogue on Italian spiders was published (Canestrini & Pavesi, 1868). According to scientific literature on Italian spiders (Pantini & Isaia, 2019), records of *L. rufescens* in indoor habitats have been increasing since 2000, with only one record before 1900, four between 1960 and 2000 and seven after 2000.

Latrodectus tredecimguttatus was described based on specimens collected in Volterra (Tuscany). The species is distributed across a wide area in the Palaearctic region, from the Mediterranean basin to Ukraine, Caucasus, Central Asia and China (World Spider Catalog, 2020). In Italy, as well as in most other countries, the Mediterranean black widow is preferably found in ruderal areas of agricultural land and, just like *L. rufescens*, has been living close to humans for centuries. However, according to scientific literature on Italian spiders (Pantini & Isaia, 2019), most records of this species refer to natural or semi-natural (agricultural) habitats and only in one case (Pepe, 2005) has the species been reported in synanthropic habitats.



BOX FIGURE 1 (a) *Cheiracanthium punctorium*, (b) *Latrodectus tredecimguttatus*, (c) *Loxosceles rufescens*, (d) *Zoropsis spinimana*. Photo credit: (a-b) Marco Colombo; (c) Emanuele Biggi; (d) Marco Bertolini. [Correction added on 7 September 2020, after first online publication: the photographer name has been corrected.]

('Regional' or 'National'). We classified newspaper circulation as 'Regional' if their total circulation was below 50,000 copies and as 'National' if it was above 50,000 copies, using the 2017 Assessment for Press Circulation provided by the society Accertamenti Diffusione Stampa (ADS) srl. Whenever newspapers were not covered in this report, we used the information found on each newspaper's webpage.

Then we read the full article and scored the (e) spider species as it was mentioned in the media report (even if the species attribution was incorrect based on indirect evidence), (f) type of event ('encounter', 'bite' or 'deadly bite'), (g) year of the event, (h) location of the event, (i) presence/absence of photographs of the spider, (j) presence/absence of photographs of the bite, and (k) possible mention of an expert-opinion (doctor, arachnologist or general biologist). Since several media reports were discussing the same event, we created an identifier for each unique event (ID), by combining location and year of the event (e.g. 'Terni_2018'). We also derived WGS84 coordinates for each event location, by geo-referencing the nearest city on *Google Earth*.

Following Nanni et al. (2020), we expressed the success of each media report as its spreading on social media, using the number of total shares in Facebook. We chose Facebook, as it is one of the most used social media platforms in Social Science research (e.g. Kramer, Guillory, & Hancock, 2014; Wilson, Gosling, & Graham, 2012). We extracted Facebook shares using the API tool available on ShareCount webpage (www.sharedcount.com; accessed on 2 March 2020). When the number of shares exceeds 999, this tools returns a rounded number (e.g. 1K for number of shares between 1,000 and 1,999). In such cases, we used the lowest number (1,000). Even though we compared the number of shares for media reports published in different years, we consider this a reliable approach (see Nanni et al., 2020). Indeed, the share of online news on social media typically reaches a stable plateau at 30 days after publication (Papworth et al., 2015).

2.3 | Scientific quality of the media reports

We assessed the quality of each media report by checking for the presence/absence of four types of errors in text and figures:

1. Errors in photographs, when the photograph(s) of the species in the media report (if any) did not correspond to the species mentioned in the text, or when the attribution was not possible (e.g. blurry photographs);
2. Errors in systematics and taxonomy, like the common mistake of considering spiders 'insects' (Jambrina, Vacas, & Sánchez-Barbudo, 2010), but also subtle inaccuracies in term of Linnaean taxonomic ranks (e.g. ID 271 [translated]: '… the '*malmignatta*', a *genus* of Italian spider belonging to the *family* of the *species* of the *black widow*');
3. Errors in venom and other physiological or medical aspects or terminology (e.g. ID 147 [translated]: '… the *venom sac* was removed with surgery'); and
4. Errors in morphology and anatomy, such as the frequent 'spider sting' instead of 'spider bite' (Afshari, 2016).

Each error type was scored as present or absent, thus we did not count cumulative errors of the same type in the same report.

2.4 | Classification of sensationalism

Three authors (MI, SM and VN) independently evaluated the title, subheadings and main text of each media report, and assessed it as overstated (sensationalistic) or not (neutral). We took the consensus between the three independent evaluations to minimize the effect of subjectivity. Sensationalism in animal-related media reports is often associated with emotional words and expressions (Bombieri et al., 2018; Nanni et al., 2020). In our case, frequent words associated with sensationalistic content were alarm ('allarme'), agony ('agonia'), attack ('attacco'), devil ('diavolo'), fear ('paura'), hell ('inferno'), killer ('assassino'), nightmare ('incubo), panic ('panico'), terrible ('terribile') and terror ('terrore'). Examples of titles (literally translated from Italian) of sensationalistic versus non-sensationalistic media reports focusing on the same event are, respectively: (a) '[…] Sardinia and the nightmare of venomous spiders' versus 'Black widow spider spotted in Sardinia, but the expert is happy: it is an indicator of biodiversity'; (b) 'Alarm in Rome: Violin spiders strike again and again. Boom of hospitalisations' versus 'Bitten by a violin spider, he was immediately hospitalized'; or (c) 'Attacked by a violin spider, traffic warden miraculously survived' versus 'Be aware of the violin spider: if it bites you, it can be dangerous'.

2.5 | Data analysis

We conducted all analyses in R (R Core Team, 2018). We graphically explored the content of media reports with barcharts and boxplots with 'ggplot2' (Wickham, 2016). For the two most abundant species, *L. tredecimguttatus* and *L. rufescens*, we explored temporal distribution of media reports using density plot, by computing a kernel density estimate with a 1.5 bandwidth adjustment for both the annual and monthly distribution of media reports (Wickham, 2016). For this and the following analysis, we excluded media reports published in 2020 given this year was covered only up to February.

We used GLMM to explore the factors driving the share of news on Facebook. We followed Zuur and Ieno's (2016) protocol for presenting regression-type analyses, whereby we: (a) conducted data exploration and identified the dependency structure in the data; (b) explained, fitted and validated the regression models; and (c) interpreted the regression output and presented the main effect plots.

The data exploration revealed the presence of four outliers in the number of shares, namely media reports shared over 15,000 times on Facebook. We removed these four observations from

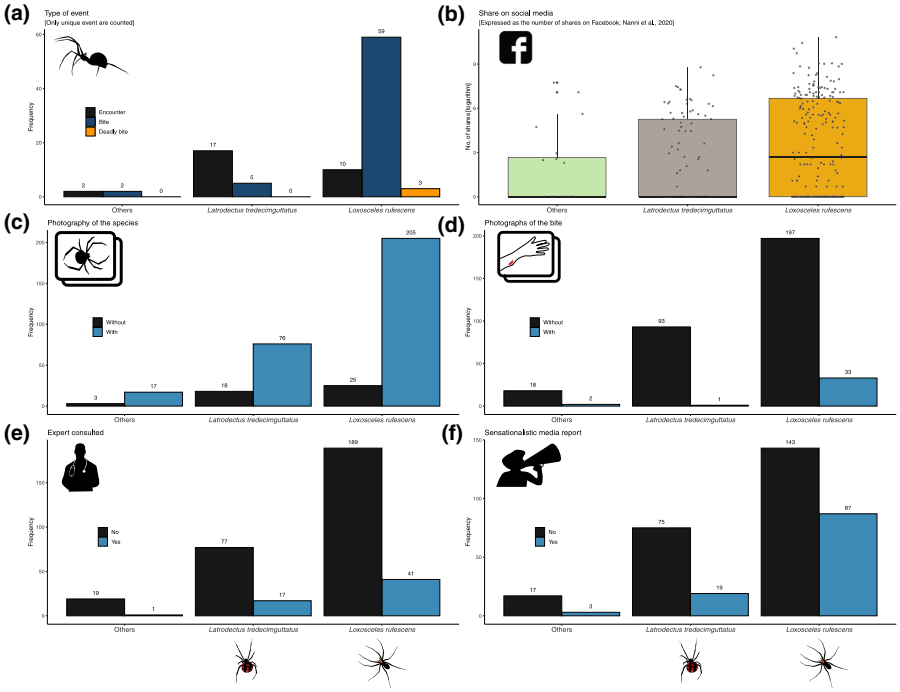


FIGURE 2 Content of media reports: (a) Type of event covered by media reports focusing on *Latrodectus tredecimguttatus*, *Loxosceles rufescens* and other species. (b) Logarithm of total number of shares on Facebook (the grey dots are jittered observed values, whereas the boxplots summarize median, quantiles and range). (c) Frequency of species photographs in media reports. (d) Frequency of bite photographs in media reports. (e) Frequency of expert consultancy in media reports. (f) Frequency of sensationalistic versus non-sensationalistic media reports

the database. Furthermore, we observed that 39.5% of media reports were never shared on Facebook (Figure 2b). However, since these are 'true zeros' (sensu Blasco-Moreno, Pérez-Casany, Puig, Morante, & Castells, 2019), we did not apply zero-inflated models.

We fitted GLMMs with 'glmmADMB' (Fournier et al., 2012), starting from an initial structure that included all covariates and random terms of interest:

$$\begin{aligned}\text{Share} \sim\ & \text{Event type} + \text{Circulation} + \text{Year} + \text{Month} + \text{Month}^2 \\ & + \text{Sensationalism} + \text{Species} + \text{Figure (species)} + \text{Figure (bite)} \\ & + \text{Expert opinion} + \text{random (Newspaper)} + \text{random (ID)}. \\ & \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad (1;\ \text{in R notation})\end{aligned}$$

The random factor 'Newspaper' was introduced because reports published in the same newspaper usually share a similar language, style and graphical elements. The random factor 'ID' was introduced to take into account the fact that multiple reports in our dataset discussed the same events. We included the square of month (term month^2) to capture a possible seasonal response of the shares during the year (i.e. a quadratic relationship between shares and month).

The numbers of Facebook shares are counts, so we initially chose a Poisson distribution. The Poisson GLMM was, however, highly over-dispersed (χ^2: 227,751,553,743; $p < 0.001$) and so we switched to a negative binomial distribution. Once the initial model had been fitted, we performed a step-wise model selection in 'MuMIn' (Bartoń, 2019). We based the model reduction on Akaike Information Criterion (AIC) and Akaike weights (w_i(AIC); Burnham & Anderson, 2004), in order to simplify the model and avoid overfitting (Hawkins, 2004).

3 | RESULTS

3.1 | Content of media reports

We collected and analysed 314 media reports published between 2010 and 2020, discussing 344 spider-related events attributable to 97 unique events (Figure 1b). The database with the analysed media reports is available in Figshare (Mammola, Nanni, Pantini, & Isaia, 2020). The average (±*SD*) number of media reports discussing each event was 3.52 ± 6.72 (range 1–33). The two most discussed events were (a) the story of a traffic warden from Terni who was supposedly bitten by a Mediterranean recluse spider in 2018, covered by 33 media reports; and (b) the story of a woman supposedly bitten in 2019 by a Mediterranean recluse spider while sunbathing in Collecchio, covered by 31 media reports. All other events were covered by 20 media reports or fewer.

Most media reports focused on *L. rufescens* (n = 230; 66.9%) and *L. tredecimguttatus* (n = 97; 27.3%; see Box 1 for a brief account on these species). Other species—*C. punctorium* (n = 14), *Steatoda* sp. (n = 4), and unidentified (n = 2)—were poorly represented (5.8%) and so we merged these under the category 'Others'. Reports on *L. tredecimguttatus* mostly discussed human-spider encounters (Figure 2a), e.g. a farmer spotting a black widow while working in his field or a tourist photographing the species during a hike. Conversely, reports on *L. rufescens* mostly referred to bites (real or otherwise), including three unverified fatal cases (see below). Most media reports contained one or more photographs of the species (n = 298; 86.6%; Figure 2c), whereas only *c.* 10% of media reports contained photographs of the bite (n = 33; Figure 2d). Expert were sporadically mentioned in media reports (Figure 2e) and sensationalistic contents were more frequent in media reports referring to *L. rufescens* rather than other species (Figure 2f).

The three casualties associated with a bite by *L. rufescens* reported in the media reports were unverifiable. The only scientifically supported fatality refers to a case of loxoscelism in a woman, 65, dating back to 2015. This event was discussed in the medical literature (Pezzi et al., 2016), and was later mentioned by seven media reports. However, the reliability of the medical report was readily questioned by Nentwig et al. (2017), because the identity of the spider biting the woman was not ascertained. Allegedly: '*[The woman] was bitten the evening before hospitalization while cleaning the home cellar by a spider, which, from the description and place where the bite occurred, could probably be identified as the* L. rufescens *species*' (Pezzi et al., 2016). Two other fatalities covered in the media reports—Cagliari (2017) and Aosta (2020)—are unverifiable, and most likely wrong, given that neither was the bite ascertained nor was the spider collected and identified. The validity of these reports was even questioned in some newspapers, for example ID 229 stating that '*The story of the men who died due to a violin spider bite is probably fake news*', or ID 115 observing that '*… he died three months after being stung* [bitten] *by a violin spider. But the cause of his death could be another*' (titles literally translated).

3.2 | Quality of media reports

One or more error types were present in 73% of media reports (Figure 3). The distribution of errors varied, however, depending on the species: most media reports referring to *L. tredecimguttatus* and other species contained no errors, whereas most reports on *L. rufescens* contained one or more errors (Figure 3a). The most frequent errors referred to spider morphology and anatomy (55.3%), species photographs (28.4%) and systematics and taxonomy (25.8%). Errors referring to venom and other physiological aspects were present in 15% of media reports (Figure 3b–e).

3.3 | Temporal distribution of media reports

We observed a strong temporal signal in the distribution of media reports between 2010 and 2019, with a recent increase in the number of news for both species, which was rather steadily increasing in *L. tredecimguttatus* and almost exponential in *L. rufescens* (Figure 4a). In particular, *L. rufescens* began appearing in the media spotlight in the past 5 years (Figure 4a). The increase of reports focusing on this species, often of poor quality (Figure 3a) and with highly sensationalistic content (Figure 2f), started just after the publication of the first supposed case of fatal loxoscelism in Europe (Pezzi et al., 2016). Coincidentally, this increase also came after the publication in Italy of *Quand sort la recluse*, a crime novel by Fred Vargas, where Chief inspector Jean-Baptiste Adamsberg has to deal with a series of murders committed using the venom of *L. rufescens*. While there is probably no causal relationship between these events and the increase in number of reports, it is interesting to note that several recent media reports in our database referenced both sources.

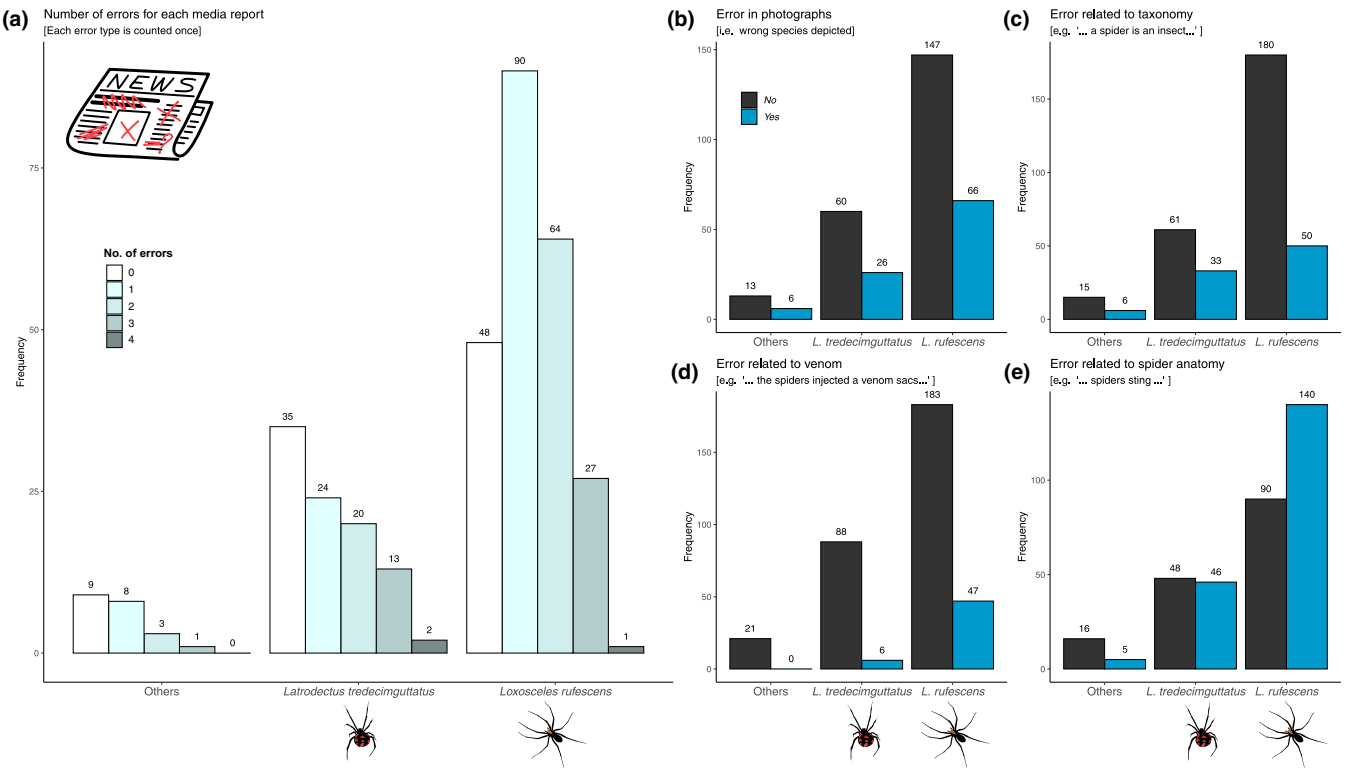


FIGURE 3 Quality of media reports: (a) Total number of error for media reports focusing on *Latrodectus tredecimguttatus*, *Loxosceles rufescens* and other species. (b) Errors related to the photographs of spiders included in the media reports. (c) Errors related to the taxonomy of spiders. (d) Errors related to the effect of the venom of spiders. (e) Errors related to the anatomy of spiders

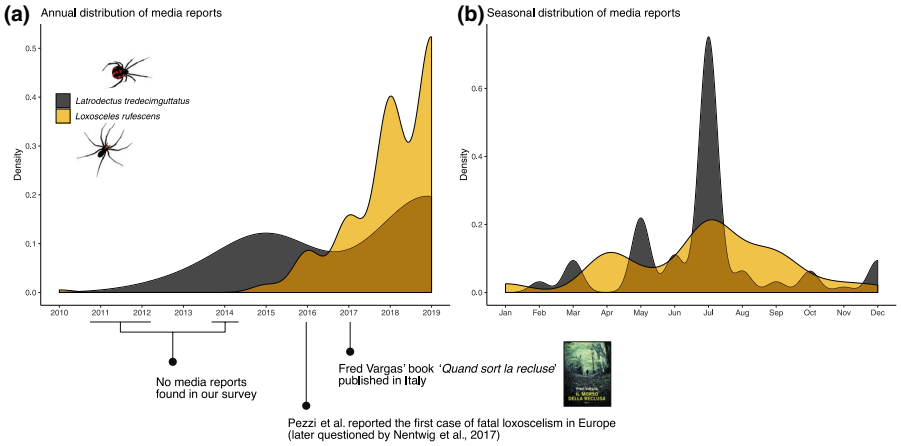


FIGURE 4 Temporal distribution of media reports: The cumulative curves for media reports referring to *Latrodectus tredecimguttatus* and *Loxosceles rufescens* are estimated with a kernel density. (a) Annual distribution of media reports between 2010 and 2019. Few remarks are highlighted on the *x*-axis (see main text for details). (b) Monthly distribution of media reports (cumulative of all years)

TABLE 1 Result of model selection and estimated regression parameters. Estimated regression parameters (Estimated $\beta \pm SE$) for fixed terms are given only for the selected model (Share ~ Year + Sensationalism)

Competing models	Estimated $\beta \pm$ SE	*p*	*df*	AIC	ΔAIC	w_i
Intercept	−2,688.36 ± 434.44	—	6	3,057.76	0.0	0.414
Year	1.33 ± 0.22	$5.6\ e^{-10}$				
Sensationalism	1.15 ± 0.50	0.02				
Share ~ Circulation + Year + Sensationalism	—	—	7	3,059.16	1.40	0.206
Share ~ Circulation + Year + Sensationalism + Expert opinion	—	—	8	3,059.72	1.96	0.156
Share ~ Circulation + Year + Sensationalism + Figure (bite) + Expert opinion	—	—	9	3,060.40	2.64	0.111
Share ~ Circulation + Year + Sensationalism + Figure (species) + Figure (bite) + Expert opinion	—	—	10	3,061.48	3.72	0.065
Share ~ Circulation + Year + Sensationalism + Species + Figure (species) + Figure (bite) + Expert opinion	—	—	11	3,063.16	5.40	0.028
Share ~ Event type + Circulation + Year + Sensationalism + Species + Figure (species) + Figure (bite) + Expert opinion	—	—	12	3,064.68	6.92	0.013
Share ~ Event type + Circulation + Year + Month + $Month^2$ + Sensationalism + Species + Figure (species) + Figure (bite) + Expert opinion	—	—	14	3,065.66	7.90	0.008

Abbreviations: AIC, Akaike information criterion; *df*, degrees of freedom; w_i, Akaike weights; ΔAIC, (AIC of the model − AIC of the best model).

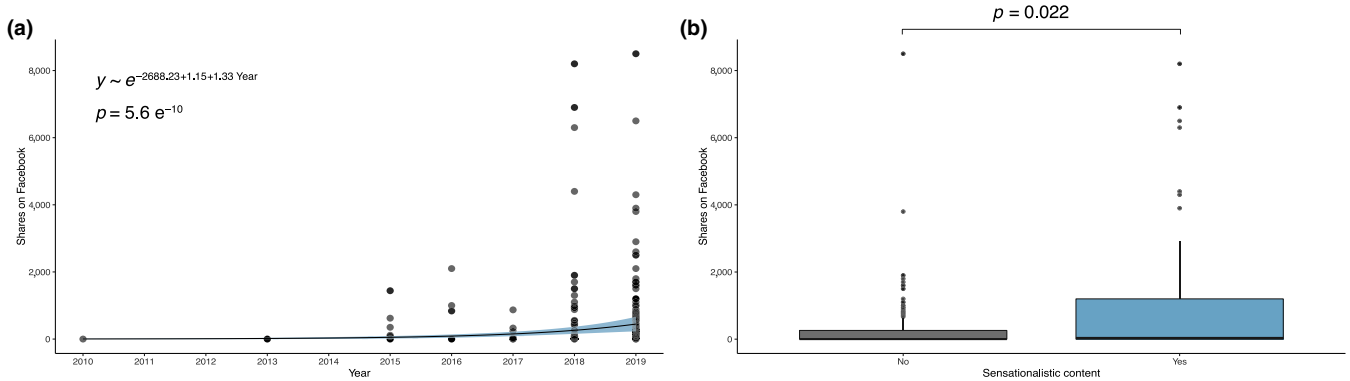


FIGURE 5 Factors driving the spreading of media reports on social media: The results are based on the most appropriate generalized linear mixed model (see Table 1 for model selection and estimated regression parameters). (a) Predicted relationship between the number of Facebook shares and the year of publication of the media report (2010–2019). To generate the prediction, the effect of all factorial terms was summed to the intercept. (b) Boxplots showing the difference between number of Facebook shares in neutral versus sensationalistic media reports

From a seasonal point of view (Figure 4b), we found that there was a clear summer peak, in July, in the frequency of reports for both species. This seasonal pattern was more evident for reports referring to *L. tredecimguttatus*.

3.4 | Factors affecting the sharing of media reports on social media

The model that minimized AIC included year and sensationalism as fixed terms (Table 1). Random effect variance (±*SE*) was 6.55 ± 3.56 for Newspaper and 3.24 e^{-5} ± 0.01 for Event_ID. We found a significant positive effect of the year of publication, with recent media reports being, on average, more frequently shared on social media (Figure 5a). Furthermore, media reports with sensationalistic content were, on average, more frequently shared on social media (Figure 5b). All other factors had no significant influence on sharing on social media, and were discarded during model selection (Table 1).

4 | DISCUSSION

4.1 | Content of media reports and temporal distribution

We found that the scientific quality of online newspaper articles focusing on spiders in Italy is, in general, rather poor, independently of the newspaper's circulation (national vs. regional). Over 70% of media reports contained errors, 32% were characterized by a sensationalistic content, and in virtually none of them was an expert consulted or interviewed. Despite our analysis does not allow any direct interpretation about the factors determining the prevalence of errors, it seems likely that journalists, maybe due to stringent deadlines, do not invest time in documenting their cases accurately, resulting in texts written quickly and not carefully. Providing the photo of a wrong species, calling a spider 'insect' or stating that a spider 'stings' rather than 'bites', are small errors that contribute to spread misinformation or may have broader implications, such as for legal cases (e.g. US District Court, 2020).

The two most represented species in the media reports were *L. tredecimguttatus* and *L. rufescens*, both widely distributed in Italy (Box 1). We found that the risk scenario depicted by the media reports with regard to *L. rufescens* was unnecessarily alarmist. First, no proven fatality due to a bite by this species has occurred globally (Nentwig et al., 2017). Second, overdiagnosis of spider bites is a rather common phenomenon for 'popular' taxa such as *Loxosceles* (Stuber & Nentwig, 2016). A conservative estimate would suggest that less than 10% of the bites reported in the media reports analysed here were delivered by the species described in the report (see Suchard, 2011). Third, in virtually none of the media reports is it written that the biting spider was brought to a hospital for identification, thus the causal attribution remains unconfirmed and merely suspected (Vetter & Isbister, 2008). Accordingly, the content of the majority of media reports analysed here has to be taken at best as anecdotic.

The quality of media reports referring to *L. tredecimguttatus* was better, and fewer reports had a sensationalistic content. The Mediterranean black widow began appearing in the media spotlight only in the past 10 years (Figure 4a), with the highest number of media reports from late spring to early autumn, paralleling the period of highest activity of the species (Nentwig et al., 2020) and corresponding to the higher possibility of human–spider encounters. Given that most media reports on *L. tredecimguttatus* were in fact 'Encounters' (Figure 2a), namely reports of the species' presence as provided by readers of the different newspapers, the distribution of news may be somehow tracking the species' phenology, making it an unusual example of iEcology (Jarić et al., 2020). However, the higher prevalence of secondary news during the summer holidays may also partly be due to the well-known trend in journalism whereby, in the absence of more relevant news, a secondary subject such as a spider bite is frequently able to make it to the front pages. Furthermore, the seasonal pattern in the distribution of news with a marked summer peak (Figure 4b), parallels what was found by Cushing and Markwell (2010) when analysing newspapers articles on the Australian endemic Sydney funnel-web spider *Atrax robustus*.

4.2 | Social media amplification of sensationalistic contents

Social media have profoundly shaped the way the information is produced and circulated, including spider-related contents. We found that the share of news on social media has increased significantly in recent years (Figure 5a), but not all news on spiders were shared with the same frequency. While sensationalistic reports represent only about one third of the total media reports analysed in this survey, these were on average shared on Facebook two to three times more than neutral news (Figure 5b). This result is in accordance with general studies demonstrating that newspaper articles with content evoking strong positive or negative emotions are more likely to become viral (Berger & Milkman, 2012). Being shared on social media, sensationalistic news will inevitably be more widely read. Due to their sensationalistic content, they are also more likely to remain imprinted in a reader's memory, especially in an arachnophobic reader's, since it has been demonstrated that arachnophobics recall spider-relevant information more effectively (Smith-Janik & Teachman, 2008). On top of this, social media platforms are a fertile ground for emotional contagion, the phenomenon whereby emotional states are rapidly transferred to others leading to massive-scale emotional homogenisation (Kramer et al., 2014). This may contribute to empowering a biased perception of risk (Gerber et al., 2011) and facilitate the persistence of arachnophobic sentiments.

4.3 | Significance of results for spider conservation

As demonstrated by Knight (2008), aesthetic and positive/negative features of animals correlate to the protection each taxon

receives. Accordingly, the main challenges facing invertebrate conservationists are to change the perceived negative connotations of invertebrates by the public (Samways et al., 2020), raising awareness about the importance of these often uncharismatic organisms for the correct functioning of ecosystems (Cardoso et al., 2020). Spiders are apical predators in the invertebrate food web (Nyffeler & Birkhofer, 2017), while also representing a key source of food for other organisms, such as birds (Rogers, Hille Ris Lambers, Miller, & Tewksbury, 2012). The importance of spiders has been even valued in economic terms, given that many species act as major biocontrol for pests in agroecosystem (Cotes et al., 2018; Michalko, Pekár, Dul'a, & Entling, 2019; Michalko, Pekar, & Entling, 2019), and their body structures, silk and venom are constant sources for bio-inspired materials and engineering solutions (Heim, Keerl, & Scheibel, 2009; Hinman, Jones, & Lewis, 2000; Kang et al., 2014), as well as pharmaceutical products (Moore, Leung, Norton, & Cochran, 2013; Saez et al., 2010). Nevertheless, spiders are still largely underrepresented in global and regional conservation policies, particularly when compared to vertebrates (Davies et al., 2018; Fukushima, Mammola, & Cardoso, 2020; Leather, 2013) or charismatic insects such as butterflies and dragonflies. In Europe, for example, spiders are almost entirely absent from international and national conservation policies (Mammola, Riccardi, et al., 2020), as well as from Italian legislation (Milano, Pantini, Mammola, & Isaia, 2017).

Traditional media have the potential to play an important role in changing the *status quo*, by offering the public unbiased representations of spiders. In fact, the traditional media arguably remain among the most powerful communication tools, capable of delivering their message effectively especially thanks to the aid of social media (Ju, Jeong, & Chyi, 2014). If this potential is harnessed to the goal of delivering accurate information to the public at large (Papworth et al., 2015), this would facilitate the much-needed transition toward an unbiased protection of the diversity of life. Thus, we urge journalists to renew their efforts toward objectivity and accuracy, which are best achieved by: (a) consulting and interviewing experts; (b) referring to scientific literature, as well as to modern online resources led by expert arachnologists (e.g. the @RecluseOrNot and @Arachno_Cosas projects on Twitter); and iii) avoiding unmotivated sensationalism when describing biting events.

4.4 | Future avenues of research

We only scratched the surface of the media representation of spiders, leaving open several questions and avenues for research. The temporal span of our study mostly covered the advent of online journalism and the diffusion of social media. In recent years, social media platforms have become an important battlefield for political debates (Hall, Tinati, & Jennings, 2018), as well as the primary digital environments where people inform themselves and frame their perception of the world (Weeks, Ardèvol-Abreu, & Gil de Zúñiga, 2015). In parallel, social media has emerged as the preferential channel though which traditional news is disseminated and discussed (Lee & Ma, 2012), with most newspapers now actively using Facebook and Twitter to spread their online contents more effectively (Ju et al., 2014). Under this perspective, an interesting endeavour would be to compare our results with the media representation of spiders from before online access to newspaper was widespread, and how this may link to the change in their conservation status. Given the exponential rise in the volume of spider-related news we observed here (Figure 4a), and the pattern of sensationalistic news spread on social media (Figure 5), one might predict the issue to be less severe prior to the arrival of such a wide range of dissemination opportunities.

Importantly, this research exemplifies a methodological approach that is efficient and inexpensive, and thus can be reproduced—with minor adjustments—in other cases. To the best of our knowledge, there are few studies similar to this one and mostly focused on vertebrates (Bombieri et al., 2018; Nanni et al., 2020), that can be used for making comparisons. To bridge this gap, one could explore media representation of a broader selection of taxa, including animals that that are not stigmatized in the same way (e.g. bees; Smith & Saunders, 2016), but also other feared and/or venomous animals (e.g. snakes; McNamee, 2001). A similar exercise would allow to compare if the levels of misinformation and sensationalism is the same across a broad spectrum of taxa, testing the prediction if a negative framing by the traditional and social media translates to a lower chance of being prioritized for conservation, and vice versa. Also, it would be worth to compare the representation of spiders across different social media platform, to explore the generality of the pattern and the reasons for divergences.

Finally, one may argue that the newspaper representation of spiders in Italy might represent only a very specific case. Thus, an interesting follow-up to this study would be to compare the quality of the Italian news with those in countries with either a greater number of species capable of causing medically significant species (e.g. South Africa, South America and Australia) or no such species (e.g. North European countries). This information would allow to infer if biological and socio-economic factors affect the quality and sensationalism of the newspapers of a country, and how ultimately this correlates to the general conservation status of species.

4.5 | Conclusions

Fear of spiders is one of the most prevalent animal-related phobias in humans (Mammola et al., 2017) and thus, spider-related contents are an effective emotional trigger (Smith-Janik & Teachman, 2008). We have shown how some journalists are able to exploit arachnophobic sentiments, framing sensationalistic news capable of attracting substantial online attention. Sensationalistic news that dramatize and overstate the frequency of spiders 'attacks' on humans are also those which most attract social media. Through emotional contagion, this biased representation is spread online.

The persistence of arachnophobic sentiments in the society, fueled also by the media framing, has far-reaching implications. Not only it may result in lowering public tolerance for spiders and

in leading to lower willingness for conservation and management efforts. It may also imply that less researchers and amateur naturalists will end up studying spiders compared to more charismatic taxa. In the long run, this may generate a vicious circle where research, conservation, and correct information about spiders will be progressively penalized. This problem may be particularly pervasive in Italy, given that the general culture regarding natural history is not as developed as in countries in Central and Northern Europe.

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CONFLICT OF INTEREST

None declared.

AUTHORS' CONTRIBUTIONS

S.M. framed the study, performed analyses, prepared figures and wrote the first draft; S.M., V.N., P.P. and M.I. managed data. All authors contributed to the writing and the revisions.

DATA AVAILABILITY STATEMENT

Data supporting this study are available in Figshare: https://doi.org/10.6084/m9.figshare.12593315.v1 (Mammola, Nanni, et al., 2020).

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